

CLAIMS

What is claimed is:

1 1. An apparatus for characterizing optical properties of a
2 sample, comprising:

- 3 a) a light source for generating a broadband beam;
4 b) at least a first set of components defining a first
5 light path, said components including at least a first
6 component pair of a planar mirror and a parabolic
7 mirror with a first focal length and a second
8 component pair of a planar mirror and a parabolic
9 mirror with a second focal length, wherein said
10 broadband beam illuminates said planar mirror and said
11 parabolic mirror in said first component pair and said
12 planar mirror and said parabolic mirror in said second
13 component pair at angles substantially near normal to
14 said planar mirror and said parabolic mirror in said
15 first component pair and said planar mirror and said
16 parabolic mirror in said second component pair; and
17 c) an element onto which said broadband beam is
18 illuminated, wherein said broadband beam illuminates
19 said element at angles substantially near normal to
20 said element.

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1 2. The apparatus of claim 1 wherein said planar mirror
2 and said parabolic mirror in said first component pair
3 are positioned such that said broadband beam exiting
4 said first component pair is collimated.

1 3. The apparatus of claim 1 wherein said planar mirror
2 and said parabolic mirror in said second component
3 pair are positioned such that said broadband beam
4 entering said second component pair is collimated.

1 4. The apparatus of claim 1 wherein said planar mirror
2 and said parabolic mirror in said first component pair
3 each has a UV-enhancing aluminum coating.

1 5. The apparatus of claim 1 wherein said planar mirror
2 and said parabolic mirror in said second component
3 pair each has a UV-enhancing aluminum coating.

1 6. The apparatus of claim 1 wherein said first focal
2 length of said parabolic mirror in said first
3 component pair is different than said second focal
4 length of said parabolic mirror in said second
5 component pair.

1 7. The apparatus of claim 1 wherein said first set of
2 components further comprises a polarizing means.

1 8. The apparatus of claim 7 wherein said polarizing
2 means polarizes said broadband beam in one of two
3 orthogonal directions.

1 9. The apparatus of claim 7 wherein said polarizing
2 means further comprises a rotatable polarization
3 analyzer.

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1 10. The apparatus of claim 1 wherein said element is
2 selected from the group consisting of a sample and a
3 first detector.

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1 11. The apparatus of claim 10 further comprising a
2 polarizing means in said first detector.

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1 12. The apparatus of claim 11 wherein said
2 polarizing means further comprises a
3 rotatable polarization analyzer.

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1 13. The apparatus of claim 10 wherein said first
2 detector is a spectroscopic ellipsometer.

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1 14. The apparatus of claim 1 wherein said broadband beam
2 has wavelengths lying in a range between 190 and 1100
3 nm.

4
1 15. The apparatus of claim 1 wherein said broadband beam
2 has a diameter of greater than 500 μm at said light
3 source and a diameter lying in a range between 50 and
4 80 μm when illuminated onto a top surface of said
5 sample.

6
1 16. The apparatus of claim 1 further comprising a means of
2 mechanically displacing said second component pair
3 while maintaining relative position of said parabolic
4 mirror and said planar mirror such that distance from

5 said parabolic mirror and a top surface of said sample
6 is such that said broadband beam is focused.

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1 17. The apparatus of claim 1 further comprising a second
2 set of components defining a second light path,
3 wherein said element is a first detector.

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1 18. The apparatus of claim 1 further comprising a third
2 set of components defining a third light path.

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4 19. The apparatus of claim 18 wherein said first
5 focal length of said parabolic mirror in said
6 first component pair in said third light path and
7 said second focal length of said parabolic mirror
8 in said second component pair in said third light
9 path are different than said first focal length
10 of said parabolic mirror in said first component
11 pair in said first light path and said second
12 focal length of said parabolic mirror in said
13 second component pair in said first light path.

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1 20. The apparatus of claim 18 wherein said element is
2 a first detector.

3
1 21. The apparatus of claim 18 wherein said element is
2 a second detector.

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1 22. The apparatus of claim 21 further comprising
2 a polarizing means in said second detector.

3
1 23. The apparatus of claim 22 wherein said
2 polarizing means further comprises a
3 rotatable polarization analyzer.
4

1 24. The apparatus of claim 21 wherein said
2 second detector is a spectroscopic
3 ellipsometer.
4

1 25. The apparatus of claim 18 further comprising a
2 fiber for redirecting said broadband beam.
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1 26. A method of characterizing optical properties of a sample
2 comprising the steps of:

- 3 a) providing a sample to be characterized;
4 b) generating light in a broadband beam;
5 c) magnifying and illuminating said broadband beam
6 onto a top surface of said sample in a first set
7 of reflective components defining a first light
8 path, wherein changes in polarization of said
9 broadband beam are minimized by ensuring that
10 said broadband beam illuminates said reflective
11 components in said first light path and said
12 sample at angles substantially near normal to
13 said reflective components and said sample;
14 d) magnifying and illuminating said broadband beam
15 reflected from said top surface of said sample to
16 a first detector in a second set of reflective
17 components defining a second light path, wherein

changes in polarization of said broadband beam are minimized by ensuring that said broadband beam illuminates said reflective components in said second light path and said sample at angles substantially near normal to said reflective components and said sample;

e) measuring an intensity of said broadband beam reflected from said top surface of said sample with said first detector; and

f) determining optical properties of said sample based on said intensity of said broadband beam reflected from said top surface of said sample.

27. The method of claim 26 further comprising the step of polarizing said broadband beam in said first light path in one of two orthogonal directions.

28. The method of claim 26 further comprising the step of focusing said broadband beam illuminating said top surface of said sample in said first light path.

29. The method of claim 26 further comprising the step of focusing said broadband beam reflected from said top surface of said sample in said second light path.

30. The method of claim 26 further comprising the step of adjusting polarization of said broadband beam reflected from said top surface of said sample in said second light path.

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1 31. The method of claim 26 wherein said broadband beam has
2 wavelengths lying in a range between 190 and 1100 nm.
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1 32. The method of claim 26 further comprising the steps:

2 h) magnifying and illuminating said broadband beam
3 from a bottom surface of said sample, after
4 transmission of said broadband beam from said top
5 surface of said sample through said sample, to a
6 second detector in a third set of reflective
7 components defining a third light path, wherein
8 changes in polarization of said broadband beam
9 are minimized by ensuring that said broadband
10 beam illuminates said reflective components in
11 said third light path and said sample at angles
12 substantially near normal to said reflective
13 components and said sample;

14 i) measuring an intensity of said broadband beam
15 from said bottom surface of said sample, after
16 transmission of said broadband beam from said top
17 surface of said sample through said sample, with
18 said second detector; and

19 j) determining optical properties of said sample
20 based on said intensity of said broadband beam
21 from said bottom surface of said sample, after
22 transmission of said broadband beam from said top
23 surface of said sample through said sample.
24

1 33. The method of claim 26 further comprising the steps:

2 h) magnifying and illuminating said broadband beam
3 from a bottom surface of said sample, after
4 transmission of said broadband beam from said top
5 surface of said sample through said sample, to
6 said first detector in a third set of reflective
7 components defining a third light path, wherein
8 changes in polarization of said broadband beam
9 are minimized by ensuring that said broadband
10 beam illuminates said reflective components in
11 said third light path and said sample at angles
12 substantially near normal to said reflective
13 components and said sample;

14 i) measuring an intensity of said broadband beam
15 from said bottom surface of said sample, after
16 transmission of said broadband beam from said top
17 surface of said sample through said sample, with
18 said first detector; and

19 j) determining optical properties of said sample
20 based on said intensity of said broadband beam
21 from said bottom surface of said sample, after
22 transmission of said broadband beam from said top
23 surface of said sample through said sample.
24

1 34. The method of claim 26 further comprising the step of
2 focusing said broadband beam from said bottom surface of
3 said sample in said third light path, after transmission
4 of said broadband beam from said top surface of said
5 sample through said sample.